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Conference Report

NIST MEETING ON MULTICOMPONENT POLYMERS AND POLYELECTROLYTES Gaithersburg, MD June 18-20, 1997

Report prepared by

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1. Introduction

Applications of polymer blends and multiphase polymer materials continue to enjoy growth in terms of market share, consumption, and employment within the plastics industry. This growth challenges the flexibility of materials suppliers to meet customer needs with new materials and reduced product development cycles. The futility of trial and error approaches to address these challenges led industry to solicit measurement tools and methods of analysis which enhance their efforts to understand and control resin compatibility, phase morphology, and blend material properties.

Current research in the Polymer Blends and Processing Group at NIST has four areas of emphasis: measurement technology for online characterization of temperature, phase behavior, and shear deformation; shear effects on phase diagrams and phase morphology; influence of additives, compatibilizers, and fillers; and the control of interfacial effects in blends. In each of these areas the NIST program works with industry to develop measurement methods using tools of fluorescence, light scattering, neutron scattering and reflectometry, x-ray scattering, birefringence, microscopy (AFM, TEM, phase contrast) and rheology. The NIST blends group maintains a good working relationship with the Hashimoto Phasing Projects of the Exploratory Research for Advanced Technology (ERATO) program sponsored by the Japan Science and Technology Agency. This group is a Japanese counter-part to the Polymer Blends and Processing Group at NIST.

2. Conference Summary

A joint meeting was held between the Polymer Blends and processing Group of NIST and the ERATO group. The purpose of the conference was to review progress made by the NIST and ERATO groups in experimental and theoretical aspects of phase separation in polymer blends and on methods for the control of blend and block copolymer phase separation morphologies through applied fields (flow, electric) and confinement to thin films. The conference also focused on new developments in the areas of polyelectrolyte solutions, gels, colloid solutions and additives (particulates, block copolymers, dendrimers) which reflect the broadening range of mutiphase polymer materials under investigation by the NIST-ERATO groups. Distinguished academic researchers from the United States and Japan in the fields of light scattering, polymer blends, polyelectrolyte, and surface science also contributed talks and participated in the discussion of promising areas for future research.

There were approximately 60 attendees to the meeting with nearly equal reprecentation from the NIST and the ERATO groups and a combination of academic and industry outside participants.

3. Conference Highlights

The presentations (oral and poster) emphasized many common and complementary findings between the NIST and ERATO groups in the core areas of blend phase separation kinetics and of blends under strong shear. Different polymer systems were generally involved in these comparisons, showing the generarality of these findings. There were notable cases where one or the other groups had made exceptional progress on particular topics. The ERATO group, for example, presented a novel method of characterizing the curvature of interfaces formed during the phase separation of blends and these optical microscopy observations were verified in numerical model calculations of polymer blend phase separation which included fluid hydrodynamic interactions. The NIST group presented their novel measurements demonstrating the control of the phase separation morphology of thin blend films through the introduction of self-assembled alkanethiol monolayer chemical patterns on the solid substrate on which the blend films were cast. This work also demonstrated the suppression of surface-directed phase separation normal to the solid substrate in ultrathin films having a thickness less than 2000 Å. Professor Onuki from Kyoto and the ERATO group members emphasized the important roles played by fluid viscoelasticity and hydrodynamic interactions on a blend phase separation.

In addition to the contributions on the more traditional areas of blend phase separation, there were talks and posters emphasizing a broad range of polymer multiphase materials. Provocative new neutron and light scattering measurements performed at NIST were presented which suggest the formation of large equilibrium domain structures in polyelectrolyte solutions. Notably, the size of these structures was found to be largely independent of polymer molecular weight, concentration, and the chemical nature of the chain backbone (hydrophobic or hydrophilic). The ERATO group presented research showing evidence of heterogeneity in the cross-linking density of gels.

Both the NIST and ERATO groups presented novel and fundamental research in the area of multiphase polymer materials, demonstrating the value of these competitive programs in fostering research diversity. There were also examples of productive direct collaborative interactions through post-doctoral exchange, and these interactions have helped to develop a very positive working relationship between the NIST and ERATO research groups.

The discussion session at the close of the NIST-ERATO meeting considered new research opportunity areas of interest to industry and considered ways of more effectively transferring the scientific knowledge base on multiphase materials to industry. Specifically, it was suggested that the range of experimental methods should be extended beyond morphological characterization to a broad range of physical properties (mechanical, dielectric, thermal) which more readily suggest the utilization of the novel materials discovered in the course of experimental studies on model polymer blends, block copolymers, and polymers with various additives having ideal structure.

4. Future Conference

A follow-up in this year's NIST-ERATO conference will be held in Kyoto in August 1998. This conference will mark the end of the current phase of the ERATO program in polymer multiphase materials. The Japan Science and Technology Agency, however, continues to sponser a bilateral international cooperation project.